

## Energy-Absorbing, Lightweight Wheels

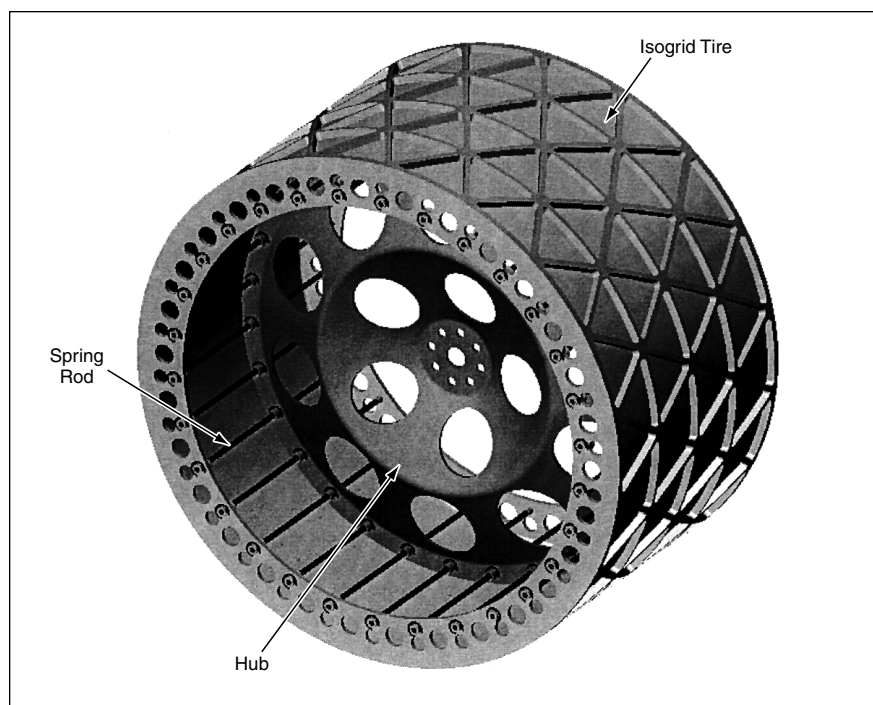
Efficient structures would absorb impact energies and distribute contact loads.

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Improved energy-absorbing wheels are under development for use on special-purpose vehicles that must traverse rough terrain under conditions (e.g., extreme cold) in which rubber pneumatic tires would fail. The designs of these wheels differ from those of prior non-pneumatic energy-absorbing wheels in ways that result in lighter weights and more effective reduction of stresses generated by ground/wheel contact forces. These wheels could be made of metals and/or composite materials to withstand the expected extreme operating conditions.

As shown in the figure, a wheel according to this concept would include an isogrid tire connected to a hub via spring rods. The isogrid tire would be a stiff, lightweight structure typically made of aluminum. The isogrid aspect of the structure would both impart stiffness and act as a traction surface. The hub would be a thin-walled body of revolution having a simple or compound conical or other shape chosen for structural efficiency. The spring rods would absorb energy and partially isolate the hub and the supported vehicle from impact loads. The general spring-rod configuration shown in the figure was chosen because it would distribute contact and impact loads nearly evenly around the periphery of the hub, thereby helping to protect the hub against damage that would otherwise be caused by large loads concentrated onto small portions of the hub.

The spring rods could be made from any of a variety of materials, depending on the nature of the anticipated loading and the



The **Spring Rods** would act as shock absorbers and load distributors between the isogrid tire and the hub.

scale of the wheel. (Experiments have shown, for example, that graphite/epoxy spring rods behave in a predictable, repeatable way.) The spring rods would be arranged in a pin/roller beam configuration to load them optimally and prevent the application of thrust loads (that is, loads parallel to the axis of rotation) to the tire. By appropriate sizing of the spring rods and

selection of the spring-rod material, the mechanical compliance of the wheel can be tailored over a wide range.

*This work was done by Peter Waydo of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) **free on-line at [www.nasatech.com](http://www.nasatech.com)**. NPO-30378*

## Viscoelastic Vibration Dampers for Turbomachine Blades

These dampers can be retrofitted to existing machines.

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Simple viscoelastic dampers have been invented for use on the root attachments of turbomachine blades. These dampers suppress bending- and torsion-mode blade vibrations, which are excited by unsteady aerodynamic forces during operation. In suppressing vibrations, these dampers reduce fatigue (thereby prolonging blade lifetimes) while reducing noise. These dampers can be installed in new turbomachines or in previously constructed turbomachines, without need for structural modifications. Moreover, because these dampers are not exposed to flows, they do

not affect the aerodynamic performances of turbomachines.

Figure 1 depicts a basic turbomachine rotor, which includes multiple blades affixed to a hub by means of dovetail root attachments. Prior to mounting of the blades, thin layers of a viscoelastic material are applied to selected areas of the blade roots. Once the blades have been installed in the hub and the rotor is set into rotation, centrifugal force compresses these layers between the mating load-bearing surfaces of the hub and the blade root. The layers of viscoelastic

material provide load paths through which the vibration energy of the blade can be dissipated. The viscoelasticity of the material converts mechanical vibration energy into shear strain energy and then from shear strain energy to heat.

Of the viscoelastic materials that have been considered thus far for this application, the one of choice is a commercial polyurethane that is available in tape form, coated on one side with an adhesive that facilitates bonding to blade roots. The thickness of the tape can be chosen to suit the specific application. The typical